

# Mobility costs in the Extended City of Aveiro-Ílhavo, Portugal

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**Keywords:** mobility costs, mobility behaviour, concentrated and dispersed urban areas, Aveiro-Ílhavo, Portugal

## Introduction

Mobility, in particular motorized one, has been one of the major causes for the changes in settlement patterns that urban areas have been undergoing, especially since the second half of the twentieth century. Traditional compact and continuous cities have given way to emergent territories whose social and spatial *rappports* have been transformed by mobility and Information and Communication Technology, while built development is increasingly intertwined with abandoned green spaces and settlement patterns become fragmented and dispersed. This *city-territory* thus encompasses old compact and continuous cores and fragments and dispersed development which, thanks to the spread of infrastructure and an increased mobility allowed by private cars, have expanded to ever-increasing areas.

This phenomenon of urban dispersion<sup>1</sup> has become the subject of much thought and research that acknowledge and describe it and, more importantly, of a growing body of literature on its advantages and disadvantages.

This long standing debate, which Breheny [1] summarises as opposing centrists to decentrists, puts forward contact with nature, spaciousness and intimacy as quality of life improvements brought by urban dispersion, lower real estate prices and road congestion as more objective advantages, besides meeting people's preferences, allowing for greater consumer lifestyle choice and proximity to local government. Conversely, its detractors see dispersed areas as simulacra of nature and sources of isolation and anonymity, while also identifying more quantifiable drawbacks, such as increased land consumption, infrastructure, real estate development and personal mobility costs due to greater distances travelled and an increased use of the private car, as well as bigger imbalances in local tax bases. [2; 3]

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<sup>1</sup> The phenomenon is worldwide, but carries local idiosyncrasies, including in Portugal. We refrain from using the term “sprawl”, more pervasive in Anglophone literature, for its use often implies certain morphologies. “Urban dispersion”, on the contrary, carries no such connotation, allowing for Portugal's several morpho-typologies of dispersed areas.

This paper will present and discuss the results of one specific task of a vaster research project that addresses this debate, by quantifying some of the costs and benefits of urban dispersion on a local scale in the Extended City of Aveiro-Ílhavo, Portugal; concretely, the task this paper is based on aims at an understanding of the mobility costs associable to dispersed and concentrated urban settlement patterns and the behaviour underlying them.

## Data and Methods

Data was collected from a questionnaire applied to a stratified sample of 432 respondents living in the Extended City of Aveiro-Ílhavo. Information on trip length, transport mode used and vehicle occupancy rates of all trips made in the weekday preceding the questionnaire was gathered.

Average mobility costs were calculated per individual per day. However they reflect a financial discount rate of 5% for a time span of 30 years. Costs for each individual were calculated according to equation 1.

$$C = \sum_i \frac{d_i \cdot CI_i}{NO_i} \quad (1)$$

Where:

$C$  is the average daily cost per individual for a 30 year period, in €/person/day;  $d_i$  is the length of a trip made on transport mode  $i$ , in km/day;  $CI_i$  is the integrated cost of transport mode  $i$  for a 30 year period<sup>2</sup>, in €/vehicle.km; and  $NO_i$  is the number of occupiers of transport mode  $i$  during the trip, in person/vehicle.

The values for  $CI_i$  are as follows in Table 1. These are integrated costs for Portugal, including both internal (investment, maintenance, energy, insurance and inspection) and external (accidents, air pollution, climate change and noise) cost components. The methodology undertaken for achieving them has been explained in [4].

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<sup>2</sup> The 30 year period was the time horizon considered for the cost-benefit comparison, for it is a reasonable lifetime for dwellings, before needing noteworthy interventions.

Transport mode	Integrated Costs (€/vehicle.km)
Light duty passenger vehicle (LD)	4,48
Heavy duty passenger vehicle (HD)	16,16
Motorcycles	14,01
Mopeds	4,6
Bicycles	5,02
Pedestrians	1,5
Passenger rail transport	136,78

Table 1: Integrated costs per transport mode in Portugal for a 30 year period in €/vehicle.km.

Costs were calculated for the whole of the Extended City, but also for its concentrated and dispersed areas. The definition of concentrated and dispersed areas merits further consideration; as they refer to settlement patterns on a local scale, they differ from more usual centre-periphery oppositions. Local scale was equated to the concept of Base Land Unit (BLU); mostly experiential, it is quite similar to those of the neighbourhood or neighbourhood unit and is associated with an appropriate population size of *circa* 3000 users and good service of local facilities [5].

Concentration and dispersion were defined from a strictly physical standpoint, resorting to spatial metrics on the relationship between built and unbuilt areas, including density, shape, continuity and compactness.

They are, thus, strictly physical, describing urban fabrics, and they are not necessarily related to a particular location in the City or a given functional mix. These two are quite frequently put forward as some of the most important characteristics of urban form influencing individual travel behaviour, so their absence of the definition of dispersed and concentrated areas must be borne in mind when analyzing results.

## Results and discussion

The mobility costs obtained for the Extended City of Aveiro-Ílhavo are shown in Table 2. These values relate to this case study only and, therefore, generalizations should be avoided.

Area	Average daily distance (km)	% of km per transport mode							Costs
		On foot	Bicycle	Motorcycle and Moped	LD 1 pax	LD 2 pax	LD > pax	Bus and Rail	
Concentrated areas	21,65	9	0,3	0,2	53	24	2	12	66,00
Dispersed areas	24,51	4	0,2	1	47	10	11	27	67,33
Extended City	22,3	8	0,3	0,1	51	20	4	16	66,31

Table 2: Average daily mobility costs (€/individual/day) in the Extended City of Aveiro-Ílhavo

Mobility costs are quite similar in concentrated (66€) and dispersed urban areas (67,33€) and in the whole of the Extended City (66,31€).

However, there are different behaviours between residents in the two settlement patterns. A resident of concentrated areas may travel 3 km less, on average, than someone living in dispersed areas, but he/she will also use public transportation significantly less, use more passenger cars with only one occupier and walk and bike more, which leads to a higher average cost per km.

In spite of these differences, average distances travelled are the main determinant of average mobility costs, there being a correlation coefficient ( $r^2$ ) of about 0,95 between both variables.

In the Extended City of Aveiro-Ílhavo, urban settlement patterns do not seem, consequently, to be a distinctive factor regarding mobility costs, a conclusion reinforced when analyzing results at a bigger scale. Similarly, there does not seem to be any characteristic opposing the two settlement patterns, except the trend in all dispersed areas for a reasonable amount of kilometers travelled in passenger cars with more than two occupants and greater use of public transport (bus and rail, including interurban trips).

Results at a bigger scale suggest there may be limited influence of the location within the Extended City in individuals' behaviour, in that average daily distances travelled are bigger in areas distant from the city centre, as well as the use of passenger cars by only one occupant. However, this sort of behaviour is not exclusive of these areas and not all areas far away from the centre behave in the same way.

## Acknowledgments

This research was conducted within the Research Project “Costs and Benefits of urban dispersion on a local scale” (FCOMP-01/0124/FEDER/007040), coordinated by Jorge Carvalho and funded by FEDER funds through the Programa Operacional Factores de Competitividade – COMPETE and by national funds through the Portuguese Fundação para a Ciência e Tecnologia (FCT).

The authors would like to thank all the team members who contributed to the discussion of the results, especially Jorge Carvalho; and Paulo Batista, in charge of the questionnaire's data analysis.

The authors wish to thank the useful comments of the anonymous reviewer as well.

## References

- [1] **Breheny, M.** (1996), Centrists, Decentrists and Compromisers: Views on the Future of Urban Form., pp. 13-35. M. Jenks, E. Burton, K. Williams, *The Compact City: A sustainable urban form?*, Oxford Brookes University, Oxford.
- [2] **Burchell, R. et al.** (2002), *The Costs of Sprawl 2000*, TCRP and National Academy Press, Washington, D.C.
- [3] **Carvalho, J.** (2008), «Custos e Benefícios, à escala local, da Ocupação Dispersa». Apresentação de Projecto de Investigação. *Sociedade e Território*, 42, pp. 42-50
- [4] **Gomes, P. et al.** (2011), Internal and external costs of transport in Portugal. Bringing city form back into planning. Proceeding of the CITTA 3rd Annual Conference on Planning Research, Porto, May 14, Faculdade de Engenharia da Universidade do Porto, pp. 669-685
- [5] **Carvalho, J. e Marinho, R.** (2011, in press), *Planeamento de Equipamentos Locais*, DGOTDU, Lisbon.